CLAIMS

1. An apparatus for sensing a misfire in an internal combustion engine and for providing a misfire indication signal in response to the occurrence of the misfire, the apparatus comprising:

at least one cylinder of the internal combustion engine, said cylinder having a cylinder event during which fuel is combusted in said cylinder, said cylinder delivering a certain magnitude of torque during said cylinder event, said cylinder event having a time period that is inversely proportional to said magnitude of said torque; said cylinder being capable of a misfire during said cylinder event thereof and consequently providing torque of a reduced magnitude during said misfire cylinder event as a result of said misfire; and

an electronic controller that is configured to:

calculate an expected time period for a cylinder event to provide an expected time period value;

measure the actual time period of said cylinder event to provide a measured time period value; and

calculate the difference between said expected time period value and said measured time period value to provide a difference time period value;

compare said difference time period value to a predetermined threshold time; and

provide the misfire indication signal in response to said difference time period value exceeding said predetermined threshold time.

2. The apparatus of claim 1 wherein said electronic controller is configured to remove the misfire indication signal in response to other difference time periods being less that said predetermined threshold time.

3. The apparatus of claim 1 wherein:

said calculation of said expected time period value occurs during a selected cylinder event that precedes a next cylinder event; and

said measurement of said measured time value occurs during said next cylinder event.

4. The apparatus of claim 3 wherein said calculation of said difference time period and said comparison of said difference time period value with said predetermined threshold time occur after said selected cylinder event.

5. The apparatus of claim 1 wherein said calculation of said expected time period value and said measurement of said measured time value occur during a same selected cylinder event.

6. The apparatus of claim 5 wherein said calculation of said difference time period value and said comparison of said difference time period value with said predetermined threshold time also occur during said same selected cylinder event.

7. The apparatus of claim 1 wherein said electronic controller is further configured to:

calculate an expected air mass value;

calculate an expected spark advance value;

utilize said expected spark advance value and said expected air mass value to calculate an expected torque value; and

utilize said expected torque value to calculate said expected time period value.

8. The apparatus of claim 7 further including:

a speed sensor providing a control signal representative of the speed of the engine;

an engine throttle having various possible positions;

a throttle sensor configured to provide a control signal representative of a position of said throttle;

an engine air intake manifold conducting air into the at least one cylinder of the engine;

a manifold sensor associated with said intake manifold, said manifold sensor means providing control signals representative of the mass, pressure and temperature of the air being conducted by said manifold; and

wherein said speed, throttle and manifold electronic controller being responsive to selected control signals from said sensor manifold to calculate said expected air mass value.

9. The apparatus of claim 7 further including:

a speed sensor providing a control signal representative of the speed of the engine;

an engine throttle having various possible positions;

a throttle sensor providing a control signal representative of a position of said throttle;

a temperature sensor providing a control signal representative of the temperature of the engine; and

wherein said electronic controller being responsive to selected control signals from said speed, throttle and temperature sensors to calculate said expected spark advance value.

10. The apparatus of claim 1 further including:

misfiring cylinder warning means coupled to receive said misfire indication signals from said electronic controller; and

said warning means being responsive to said misfire indications signals to provide a misfire warning signal.

11. The apparatus of claim 10 wherein said misfiring cylinder warning requires a predetermine number of said misfire indicating signals to occur before generating said misfire warning signal.

12. The apparatus of claim 1 further including:

the engine having a plurality of cylinders;

misfiring cylinder identification means coupled to said electronic controller; and

said misfiring cylinder identification means enabling said electronic controller to identify any cylinder of said plurality of cylinders of the engine that is misfiring.

13. The apparatus of claim 12 wherein the internal combustion engine has an even number of cylinders, the apparatus further including:

a crank shaft angle sensor providing a pulsed signal having a time period, said period being inversely proportional to the amount of torque developed during a cylinder event by a pair of cylinders, said misfire resulting in said time period being lengthened for a pair of cylinders having a misfiring cylinder;

said crank shaft angle sensor being coupled to said electronic controller, said electronic controller storing which pair of cylinders is misfiring; and

a cam state sensor coupled to said electronic controller, said cam state sensor enabling said electronic controller to identify which cylinder of said pair of cylinders is misfiring.

14. A method for sensing a misfire in a cylinder of an engine having at least one cylinder and for providing a misfire indication signal in response to the misfire, the method comprising the steps of:

calculating an expected time period for a cylinder event during which fuel is combusted in the cylinder to provide an expected time period value;

measuring the time period of said cylinder event to provide a measured time period value; and

calculating the difference between said expected time period value and said measured time period value to provide a difference time period value;

comparing said difference time period value to a predetermined threshold time; and

providing a misfire indication signal in response to said difference time period value exceeding said predetermined threshold time.

15. The method of claim 14 further including the step of removing the misfire indication signal in response to other difference time periods being less than said predetermined threshold time.

16. The method of claim 14 wherein:

said step of calculating said expected time period value occurs during a selected cylinder event that precedes a next cylinder event; and

said step of measuring said measured time value occurs during said next cylinder event.

17. The method of claim 16 wherein said step of calculating said difference time period and said comparison of said difference time period to said predetermined threshold time also occur after said selected cylinder event.

18. The method of claim 14 further including the steps of:

calculating an expected air mass value;

calculating an expected spark advance value;

utilizing said expected spark advance and air mass values to calculate an expected torque value; and

utilizing said expected torque value to calculate said expected time period value.

19. The method of claim 14 further including the step of providing a misfiring warning signal to an operator of the engine in response to the occurrence of a predetermined number of the misfire indicating signals.

20. The method of claim 14 wherein the engine has a plurality of cylinders and further including the step of identifying any cylinder or cylinders of said plurality of cylinders of the engine that is misfiring.

21. The method of claim 20 wherein the engine has an even number of cylinders, further including the steps of:

providing a pulsed signal having a period indicative of engine crank shaft positions, said period being inversely proportional to the amount of torque developed during a cylinder event by a pair of cylinders, said misfire resulting in said time period being lengthened for a pair of cylinders having a misfiring cylinder;

identifying a pair of cylinders which produce an expected cylinder event time period of sufficient length to indicate a misfire; and

identifying which cylinder of said pair of cylinders is misfiring.